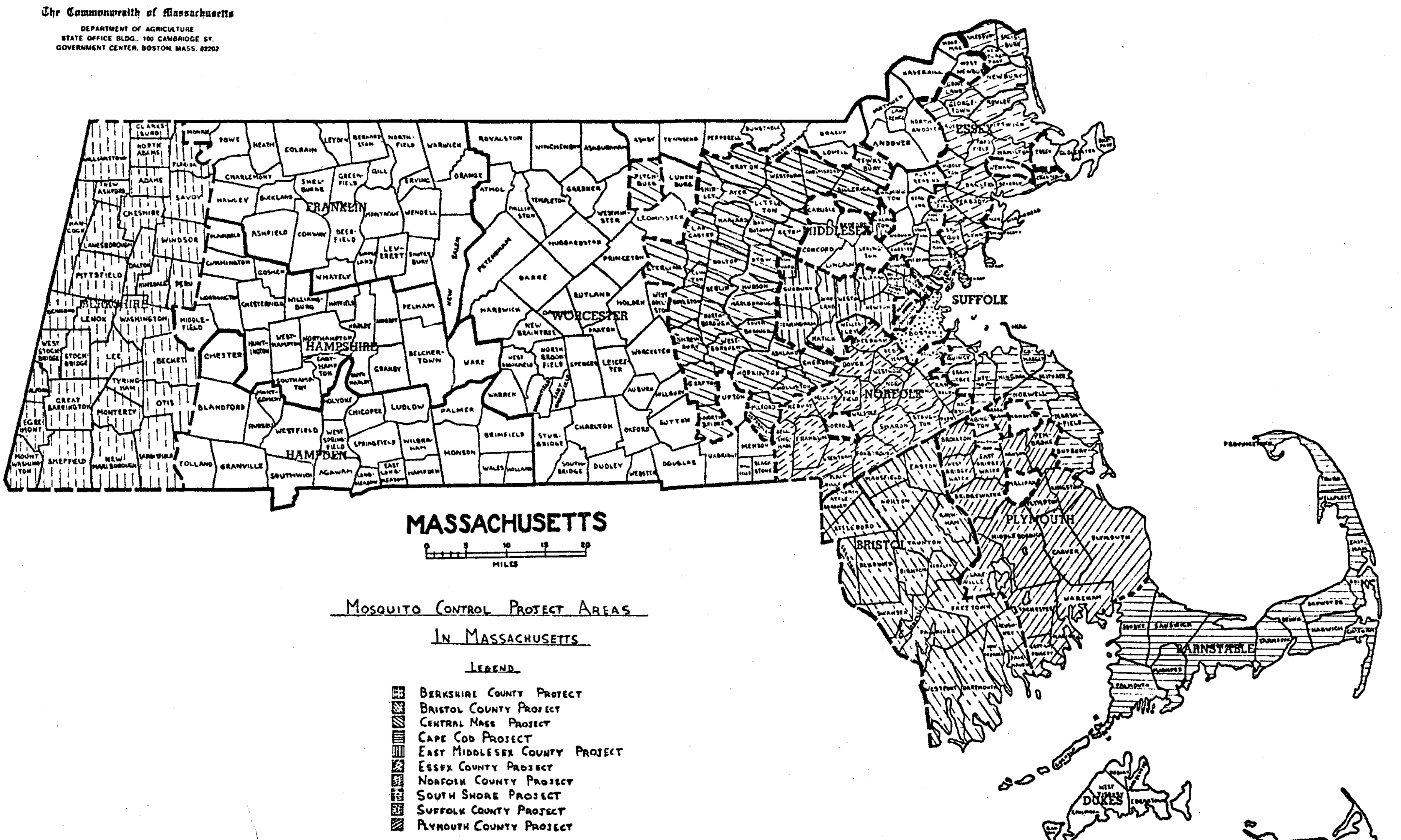
A REVIEW OF MOSQUITO CONTROL OPERATIONS IN MASSACHUSETTS WETLANDS

REGULATORY BRANCH, NEW ENGLAND DIVISON
U.S. ARMY CORPS OF ENGINEERS

Robert J. DeSista
Charles J. Newling
1979



The Commonwealth of Massachusetts
DEPARTMENT OF AGRICULTURE
STATE OFFICE BLDG., 100 CAMBRIDGE ST.
GOVERNMENT CENTER, BOSTON, MASS. 02202
BERKSHIRE
FRANKLIN
HAMPSHIRE
HAMPDEN
WORCESTER
MIDDLESEX
ESSEX
SUFFOLK
NORFOLK
BRISTOL
PLYMOUTH
BARNSTABLE
DUKES
NANTUCKET
MASSACHUSETTS
0 5 10 15 20
MILES
Mosquito Control Project Areas
In Massachusetts
Legend
Berkshire County Project
Bristol County Project
Central Mass Project
Cape Cod Project
East Middlesex County Project
Essex County Project
Norfolk County Project
South Shore Project
Suffolk County Project
Plymouth County Project

FIGURE 1

TABLE 1. MASSACHUSETTS MOSQUITO CONTROL PROJECTS

Mosquito Control Project	Address	Superintendent	Area of Jurisdiction
Berkshire County	Berkshire Co. Court House Pittsfield, MA 01201	David H. Colburn	Berkshire County
Bristol County	140 No. Walker Street Taunton, MA 02780	Frank W. Dillingham	Bristol County
Cape Cod	144 Falmouth Road Hyannis, MA 02601	Oscar W. Doane, Jr.	Barnstable County
Central Mass.	57 Hudson Street Northborough, MA 01532	David W. Scott	Parts of Middlesex & Worcester County
East Middlesex	11 Sun Street Waltham, MA 02154	Kevin R. Moran	East Middlesex County
Essex County	266 Haverhill Street Rowley, MA 01969	Robert W. Spencer	Essex County
Norfolk County	Endicott Street Norwood, MA 02062	Albert W. Heuser	Norfolk County (excluding Quincy, Braintree Weymouth, and Cohasset)
Plymouth County	183 Columbia Road Hanover, MA 02339	Arthur L. Westgate	Plymouth County (exluding Norwell, Scituate Marshfield, Hingham, & Duxbury)
South Shore	1120 Hancock Street Quincy, MA 02169	Simon J. Veneau	Coastal Norfolk & Plymouth Counties excluded above
Suffolk County	185 West First Street South Boston, MA 02111	Bruce A. Landers	Suffolk County (Boston, Chelsea)

I. History

Ditching of wetlands, especially saltmarshes, for the purposes of mosquito control has been undertaken for many years in the United States. "Mosquito ditching" accelerated and reached its peak under the Works Projects Administration (WPA) in the 1930's. During this period, the majority of the saltmarsh ditches which still exist today were originally cut. However, maintenance (re-excavation) of existing ditches and digging of new ditches is still an ongoing process today. When the spoil resulting from this work is deposited in the wetlands (as is usually the case with the spoil being deposited immediately adjacent to the ditch) the action is regulated under Section 404 of the Clean Water Act.

The New England Division of the U. S. Army Corps of Engineers first encountered a case involving jurisdiction over saltmarsh mosquito ditching when the Town of Barrington, Rhode Island applied for a permit on 13 January 1976. After expenditure of considerable time and effort in collection of background information and conducting difficult inter-agency coordinations, a permit, RI-EPRO-76-541, was agreed upon by the parties involved and issued on 1 November 1976. They again applied on 15 November 1977 for the remaining portions of their project. Once more we undertook extensive coordination and review and on 27 June 1978 Permit No. RI-EPRO-78-336 was issued.

As a result of the background information developed in the course of processing those permit requests, it became apparent that mosquito ditching and ditch maintenance in saltmarshes was a pervasive activity being undertaken by a plethora of agencies along the entire

New England Coast. Further, many inland wetlands were being worked. It was also obvious that if the normal procedure for processing the permit request required as much effort as did the Barrington request, the process would be impractical to administer and oppressive to the applicant.

Recognizing that the Federal law required action, the Regulatory Branch of the New England Division initiated a project to identify the magnitude of the problem and propose reasonable means to achieve both the objectives of the Federal law ("to maintain the physical, chemical, and biological integrity of the nations waters") and the objectives of those agencies involved in mosquito ditching activities (to decrease mosquito populations). The project was initiated during the summer of 1978 by Mr. Robert DeSista and Mr. Charles Newling. Their immediate assignment was a fact finding mission with the objectives of determining the extent and impact of New England mosquito ditching.

II. Methods

Massachusetts was chosen as the primary study area for the first summer of observation. It has considerable acreage in wetlands which is still being maintained by a series of Mosquito Control Projects. (Table 1 and Figure 1). These quasi-state level agencies provided focal points for efficient communication and coordination of our activities.

Our first step was to notify the individual Mosquito Control Projects that disposal on wetlands of spoil from creation or maintenance of ditches was under Federal jurisdiction and would require a Corps of Engineers permit. Such work is exempt from provisions of the Massachusetts Wetlands Protection Act by General Law Chapter 252.

While it was an option, the Division Engineer elected not to order the Projects to Cease and Desist their work during the interval of our fact finding mission. Since the work has proceeded continuously since the 1930's, environmental harm, if occurring, would be proceeding at a pace sufficiently slow to warrent a small grace period to learn more of the specific impacts. On the other hand, if no environmental harm were occurring and a beneficial public service was being provided a cease and desist order would be ill-advised. Appendix I provides the text of the first correspondence to the Massachusetts Mosquito Control Projects.

It was our belief that adverse impacts, if they occurred, would be of greatest severity in saltmarshes because of the innately high productivity of these wetland types. Therefore, we scheduled and conducted a series of field visits to each of the coastal Projects. At each Project we asked a series of questions developed to provide a basic understanding

Table 2.

Status of Mosquito Control Work in Massachusetts Salt & Freshwater Wetlands 1978

Project	Total Wetlands Area	Total Length, Ditches	Length New Ditches	Work Methods	Time of Year Work Performed	Avg. Main. Time	Size of Ditch	Adulticides Used	Larvicides Used	Remarks
Norfolk Co.	321 Ac. (Tidal) 44,000 Ac. (Fresh)	25.5 Mi. (Tidal) 31 Mi. (Fresh)	400 Ft.	Manual (70%) - Hand Tools Mechanical (30%) - Backhoe on Widetrack Tractor	Jan.-May Sept.-Dec.	Manual - 3 Yrs. Mech. - 30 Yrs.	Freshwater Ditch, 36" W 30" D	Under Separate Program	Organic Phosphates (1.5 Oz/Acre)	Ditches Are Small Capacity, Short, And Installed In Temporary Water Holding Swamps.
Plymouth Co.	3650 Ac. (Tidal) 37,471 Ac. (Fresh)	420 Mi. (Tidal) ? (Fresh)	3'-20', Where Necessary	Manual (70%) - Shovels, Chain Saws Mechanical (30%) - Oliver OC4, Bombadier Muskeg	Year Round, Weather Permitting	3-4 Yrs, W/ Exceptions To Areas Subject To Storms; 4-6 Yrs Rect. Schedule	Saltmarsh, 18" W 18"-24" D Inland, Variable To Stream Bed	Under Separate Program	Altosid SR10 Flit MLO	Further Information On Request
South Shore	8600 Ac. (Tidal) 12,500 Ac. (Fresh)	711 Mi. (Tidal) ? (Fresh)	Phase I - 300' Phase II - 300'	Mechanical - Scovel Plow, Backhoe	Tidal - Fall & Early Winter Freshwater - Late Winter, Spring	5 Yrs. 8-10 Yrs.	1930 - 12"x12" 1950 - 12"x18" 1960 - 24"x24"	?	Used, But Names Not Stated	None
Suffolk Co.	222 Ac. (Tidal) 386 Ac. (Fresh)	15.5 Mi. (Tidal) 5 Mi. (Fresh)	Infrequent; Extensions of Existing Ditches	Manual - Shovels, Potato Hooks	Spring - Fall	Minimal Maintenance Done To Date	Saltmarshes - 18" W 24"-36" D	Malathion	Abate 4E (1 oz/Acre) Flit MLO	Larvaciding Is The Mainstay Of Their Mosquito Management Program. Their Main Concern Is Mosquitos That Breed In Temporary Standing Water.

TABLE 2.

STATUS OF MOSQUITO CONTROL WORK IN MASSACHUSETTS SALT & FRESHWATER WETLANDS 1978

PROJECT	TOTAL WETLANDS AREA	TOTAL LENGTH, DITCHES	LENGTH NEW DITCHES	WORK METHODS	TIME OF YEAR WORK PERFORMED	AVG. MAIN. TIME	SIZE OF DITCH	ADULTICIDES USED	LARVICIDES USED	REMARKS
BERKSHIRE CO.	2151 ACRES (FRESH WATER)	18.8 MILES	100'-500' WHEN NECESSARY	MANUAL - SHOVELS, POTATO HOOK, PICK, BRUSH AXE, ETC.	SEPT.- DEC.	2-5 YRS.	2' HORIZ. VAR. HT.	FLIT MLO	METHOXY-CHLOR (1 LB/ACRE)	DITCHING IS DONE TO ELIMINATE THE NEED FOR INSECTICIDES
BRISTOL CO.	20,000 AC. (TIDAL) 100,000 AC. (FRESH)	1000 MI. (TIDAL) ? (FRESH)	NO VALUE GIVEN	MANUAL - POTATO HOOK, SHOVELS, CHAIN SAWS MECHANICAL - BACKHOE ON CRAWLER TRACTOR	YEAR ROUND, WEATHER PERMITTING	3-5 YRS. (MECH) 1 YR. (MAN.)	TIDAL - 12"-24" W 18"-24" D FRESHWATER - VARIABLE AS STREAM BED	NONE	NONE	RECORDS OF EXTENT, LOC'N & TYPE OF DITCH MAINTENANCE ON FILE; AVAILABLE ON REQUEST
CAPE COD (BARNSTABLE) CO.	32,000 AC. (TIDAL) 3200 AC. (FRESH)	2000 MI. (TIDAL) 1000 MI. (FRESH)	10' LATERALS, WHEN NECESSARY	MANUAL - SHOVELS, SAWS MECHANICAL - BACKHOE	YEAR ROUND	10 YRS. (MECH) 5 YRS (MAN.)	VARIABLE	NONE	NONE	THE WORK IS FOR STREAM CLEARING & RECLAMATION OF DRAINAGE SYSTEM
EAST MIDDLESEX	15,000 AC. (FRESH)	? (FRESH)	NONE; RECLAMATION OF EXISTING DITCHES ONLY	MANUAL - SHOVELS, POTATO RAKES, CHAIN SAWS	SEPT. - DEC. 70% MAR. - MAY 30% W/OCCASIONAL WORK IN SUMMER	3-5 YRS. IN PROXIMITY TO RES. AREAS YEARLY	18"-24" W 6"-12" D	NONE	ABATE (1½ OZ/ACRE) OR METHOXYCHLOR (12OZ)	DITCHING PROVIDES NATURAL MOSQUITO CONTROL, AND HELPS KEEP SWAMPS & MARSHES FROM BECOMING USELESS
ESSEX CO.	25,000 AC. (TIDAL) 30,000 AC. (FRESH)	2000 MI. (TIDAL) ? (FRESH)	NONE, W/ EXCEPTION OF 20'-30' LATERAL	TIDAL - CRAWLER TYPE EQUIPMENT WITH SCAVEL PLOW FRESHWATER - MANUAL, USING POTATO HOOKS, SHOVELS, ETC. 75% MECH. 25% MAN.	YEAR ROUND, WEATHER PERMITTING	SALT MARSH DITCHES, YEARLY (DUE TO STORMS) FRESHWATER DITCHES, 5 YR. MAX.	SALTWATER 16" W 18" D FRESHWATER DEPENDANT ON STREAM BED	NONE	ABATE (1OZ/ACRE)	THE MOSQUITO PROBLEM WAS CAUSED BY LONG-TIME NEGLECT OF DRAINAGE WAYS; AREA FORMERLY AGRICULTURAL
CENTRAL MASS (MIDDLESEX) & WORCESTER CO.	44,000 AC. (FRESH)	?	NONE; RECLAMATION OF EXISTING DITCHES ONLY	MANUAL (95%) - SHOVELS, LOPER SHEARS, BRUSH CUTTERS, CHAIN SAWS, ETC. MECHANICAL (5%) - WIDE-TRACK BACKHOE	FALL - WINTER; OCCASIONALLY, YEAR ROUND	2-3 YRS.	VARIABLE TO STREAM BED	SPRAYING (ITEMS NOT STATED)	ABATE 4E (½ - 1½ OZ/AC) FLIT MLO (1-5 GAL/AC) ALTOSID BRIQUETS METHOXYCHLOR 50% (2 LBS/AC.)	THEIR GOAL IS TO REDUCE MOSQUITO POPULATIONS TO TOLERABLE LEVELS, BY INCREASING THE AMOUNT OF WATER MANAGEMENT & DECREASING THE AMOUNT OF PESTICIDES. THIS IS MORE ENVIRONMENTALLY SOUND.

of the guiding principles for the mosquito control work being undertaken. We hoped to document exactly what kind of work was being done in saltmarshes, how extensive it was, and by what means (i.e., by hand, backhoe, clamshell) it was being conducted. Further, we requested and were shown examples of work done over varying intervals of time, recent, 2-3 years old, 5-10 years old, over 10 years. This would help determine whether obvious adverse environmental impacts could be identified. Representatives from the Environmental Protection Agency, Fish and Widllife Service, and National Marine Fisheries Service accompanied us on several of the visits. Finally, a questionnaire to confirm our observations was prepared and sent to each Project. (Appendix II)

III. Results and Discussion

Results of the questionnaire are documented in Table 2. Generalized observations on wetland manipulation for mosquito control in Massachusetts with specific comments regarding some of the techniques follow.

A. The Problem

A basic principle in mosquito control is: if the amount of suitable breeding areas is reduced, numbers of mosquitos will be reduced. In order to breed, mosquitos require shallow pools of stagnant (still) water where adult females lay eggs. In the absence of predactors such as fish or dragonfly larvae, a large percentage of the resultant larvae will pupate and successfully emerge as adults, (Figures 2, 3, and 4).

The adult females subsequently seek out the blood meal which is required to produce healthy eggs and complete the life cycle. There are many species of mosquitos in New England and each species varies to some degree in its life history. In general, however, breeding habitat require-

(Fig. 2) Non-breeding pond (Background) with sufficient depth to support a fish population. A breeding pond is in the foreground. (Rowley, Mass. 28 June 1978).

(Fig. 3) Close up of breeding pond shown in Fig. 2
This stagnant area, only 5-10 cm deep, is too shallow to support fish and at time of photograph, did support a large population of mosquito larvae and pupae. (Rowley, Mass. 28 June 1978)

(Fig. 4) Pockets of stagnant surface existing under a blanket of grass can often provide suitable breeding habitat for mosquitos. (Fairhaven, Mass. 18 August 1978).

ments remain similar.

As a result, the basic intent of saltmarsh ditching for mosquito control has been the same. By hastening and achieving complete dewatering of the marsh surface on falling tides, stagnant pools of water suitable for mosquito breeding are eliminated. This was the basic principle during the WPA era, although the massive amount of ditching done seemed to be without biological rhyme or reason and appeared to be done as much to "make work" as it was to control mosquitos. Workers were paid a standard rate and it seemed that more attention was paid to how great a length of ditch was installed rather than where it was laid or how effective it was. This fact is significant because we found that the overwhelming majority of the present day work being conducted in Massachusetts saltmarshes is simply the maintenance (clearing) of old ditches which tend to clog periodically with floatsam or silt and in so doing become stagnant breeding areas themselves (Figure 5). A well placed ditch will succeed in drawing off surface water. However, the conjecture was offered more than once, that, when clogged, or as they are silting in, the ditches cause as much of or an even great mosquito problem tham existed prior to the original ditching. Digging of new ditches was rare or absent on Massachusetts saltmarshes.

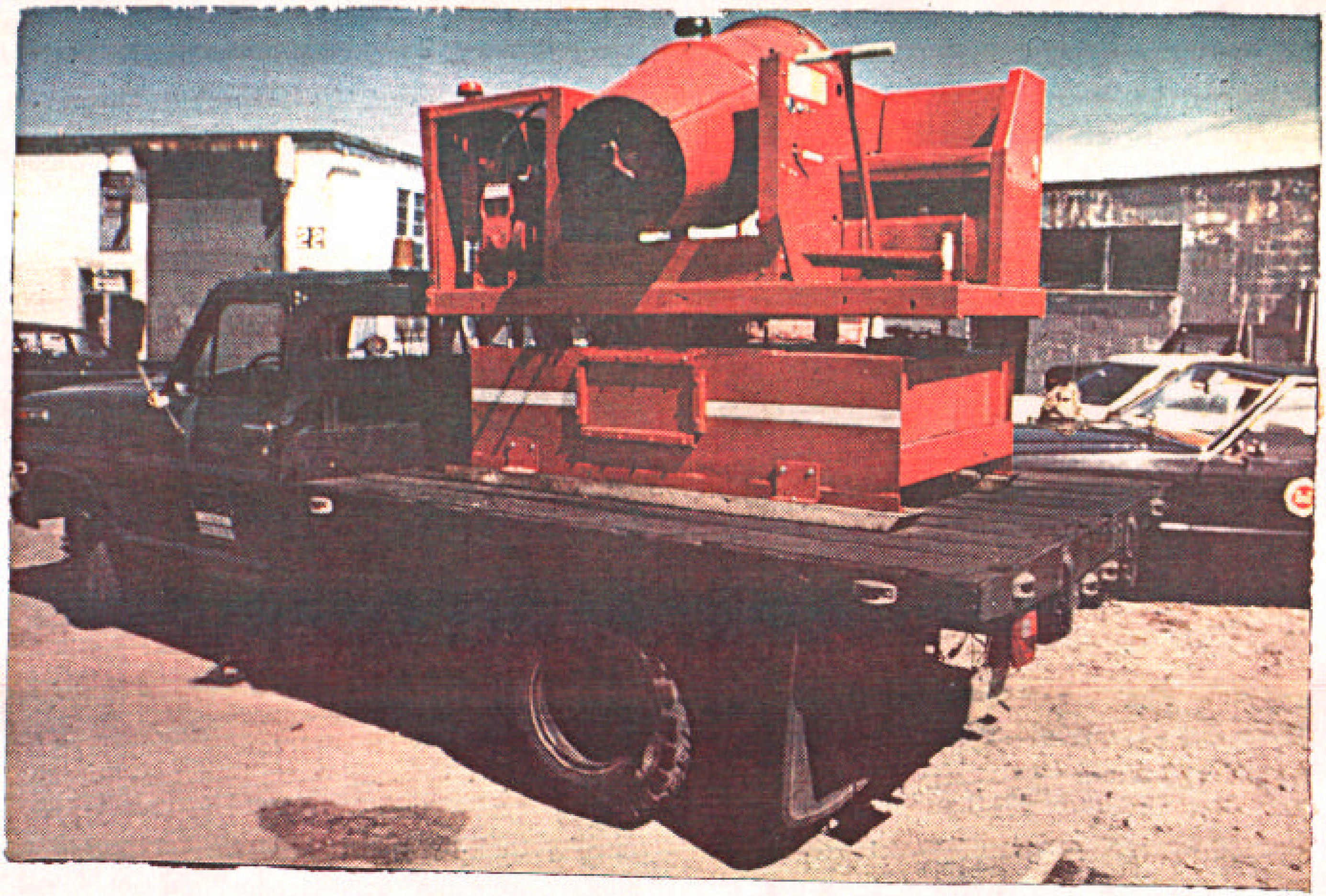
Documentation of the severity of an existing mosquito problem, or an upcoming mosquito hatch was generally loose, but apparently adequate for the needs of the Control Projects. Adult populations can be estimated by simple "landing counts" (number of mosquitos landing on an exposed area in a given time period), or by "light traps" which can provide more uniform counts over longer periods of time. However, telephone complaints from a given area per unit time is often the only "count" available. The usual response in situations of large numbers of complaints is a cosmetic approach

(Fig. 5) Mosquito ditch clogged with dead plant debris which will be cleared by hand. (Rowley, Mass. 28 June 1978).

employing a spraying truck using adulticide chemicals in hopes of providing some short term relief (Figure 6.)

Elimination of breeding areas provides much more effective and longer lasting control. Estimation of larval population is usually done by means of a dipper survey. Random dips with a standard 2 millimeter size cup are taken from suspected breeding pools (Figure 7). The larvae and pupae, both readily visible to the naked eye, are counted. Those areas with the highest counts were producing largest numbers of adult mosquitoes and could be targeted for ditch maintenance.

We found, however, that formal breeding surveys as described above and which could be used to document the severity of the mosquito problems in an area, were not normally conducted. Hard pressed for labor, time, and funding, the projects have found that such formal counts are inefficient. To a trained observer, mosquito larvae and pupae are quite obvious in the field. After years of observing both mosquito larvae and the habitat which produce them, breeding areas are usually very easy to identify for an experienced observer. Formal dipping surveys can provide useful statistical data, however, analysis of the numbers tends to bear out what is usually intuitively obvious: that high larvae counts from stagnant pools near residential areas will result in a high number of complaints from those areas if nothing is done. Doing something about the situation takes so much time and effort that the Projects have streamlined their process by eliminating formal statistical surveys in favor of informal qualitive observations. Once again, the usual situation describes areas where ditches already exist and maintenance is required rather than excavation



(Fig. 6) Truck and equipment used in spraying of adulticides. (South Shore Mosquito Control Project 8 Sept. 1978).

(Fig. 7) The standard technique for sampling mosquito larvae involves counting the larvae scooped from a potential breeding area in a 2 ml. cup. (Mattapoisett, Mass. 14 August 1978).

of new ditches.

B. Solutions

As previously mentioned, solutions can take two directions at present, chemical control using insecticides or control by physically eliminating breeding areas. While biological control methods, such as use of predacious insects, are being researched, practical means of biological control are not available for New England nor do they appear likely in the near future.

Generally, we found that the Massachusetts Mosquito Control Projects were adverse to the use of insecticides particularly adulticides (which kill adult mosquitoes), and would use chemical control means only when all other avenues had failed. When insecticides were used, they were used sparingly. They were considered to have only short term effectiveness and were cost ineffective. We especially noted among leaders of the various Projects, a high level of awareness of the ecological value of wetlands.

We found that this awareness was the reason for their avoidance of chemical control means and preference for mechanical methods which provided much more effective and longer lasting results on the mosquitoes with greatly lessened potential for environmental harm to the saltmarsh ecosystem.

Larvicides, which kill mosquito larvae, were used by most of the Projects. However, they were used in troblesome breeding areas which maintenance crews could not reach in a reasonable period of time. The most commonly used larvacide was FLIT-MLO, a mineral-oil based, mosquito-specific substance which is effective for a comparatively short period of time (2 to 3 days) and has not produced demonstrable adverse affects on other components of the saltmarsh ecosystem.

Elimination of breeding areas can be achieved in two ways: by either eliminating shallow pockets or pools of still water, or by deepening the surface water sufficiently to sustain a population of fish which will feed on the larvae. In recent years, many of these techniques have been refined by workers in New Jersey and have been labeled "Open Marsh Water Management" or "The New Jersey Method." Some of the techniques, particularly those which deepen and hold water on the marsh, have been regarded with favor by wildlife biologists because they provide the additional benefit of also creating habitat for other desirable marsh species such as waterfowl, shorebirds, and muskrats. Under "Open Water Marsh Management," ditching is directed at demonstrated breeding areas and is planned to minimize the total amount of disturbance to the minimum amount necessary. Spoil from the ditches is scattered by a special rotary ditching machine to eliminate spoil mounds. Figure 8 shows such a machine, at work in New Jersey. In the past, it has been feared that spoil deposition on the marsh has been responsible for massive invasions of woody plant species (i.e., groundsel tree, *Baccharis halimifolia* and marsh elder, *Iva frutescens*) which were thought to lower productivity of the marsh and degrade wildlife habitat.

In some contrast to New Jersey, however, we discovered that in Massachusetts, the marshes were different, the equipment was different, and while the basic approach was similar, its implementation varied. Although the saltmarsh plants and community structure in Massachusetts was similar to that in New Jersey, there was a much greater predominance of "high marsh" or "salt hay meadow" dominated by saltmeadow cordgrass (*Spartina patens*) and alkalai grass (*Distichlis*

(Fig. 8) Rotary Ditching machine spreading spoil
as it cuts ditch. (New Jersey).

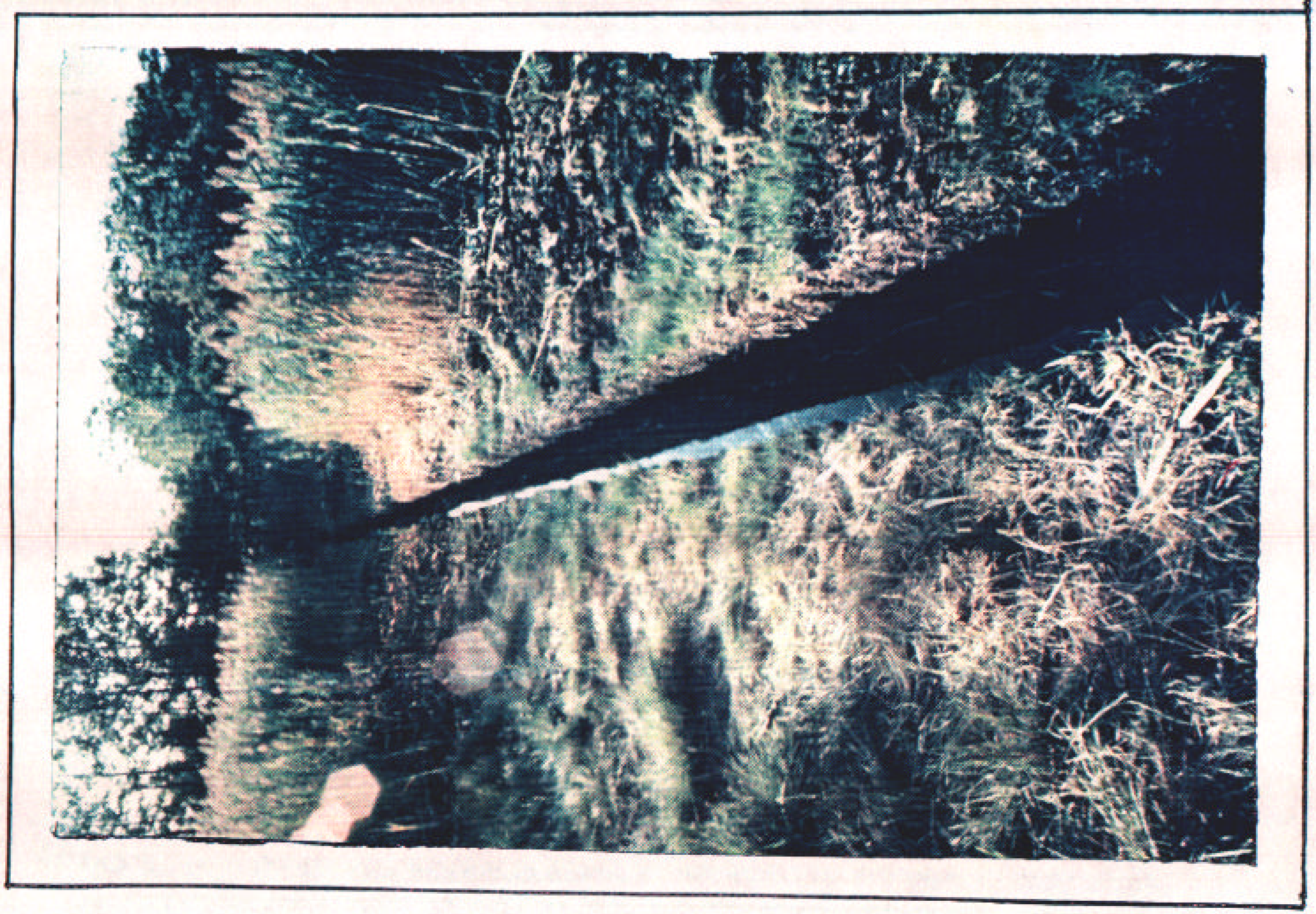
spicata) in contrast to the amount of "low marsh" characterized by saltwater cordgrass (_Spartina alterniflora_) which is predominant in the New Jersey marshes. In Massachusetts saltmarshes we found great variance in substrate from marsh to marsh which often dictated what types of equipment could be used. Some substrates were soft, some hard, some sandy which allows for natural scouring; some were free of obstructions, others were littered with buried logs and boulders. Overall, because of tight budget limitations and the bequevance of a less than desirable system of ditches created in years past, the Projects were essentially bound to a program of clearing and maintaining old ditches rather than embarking on new programs requiring additional equipment and a substantial variation in approach.

Techniques used for working ditches varied considerably but their overall effects were generally the same. When a knowledgeable operator worked with a careful supervisor, adverse impacts on the marsh appeared to be minimal or absent.

During New England Division's first encounter with mosquito ditching in Rhode Island, we observed both clearing of old ditches and cutting of new ones by hand (Figures 9 and 10). Great care was being exercised to spread resulting spoil evenly and thinly. It is generally believed that hand work such as this has the least potential for creating adverse impacts, however, it is very expensive. Clearing by hand was frequently used in Massachusetts saltmarshes particularly when simple clearing of debris or small clumps of sod is all that is required.

Use of machinery is much more efficient, particularly when the ditches have accumulated heavy deposits of silt or dense growths of sod (Figure 11). Clamshells and backhoes were the machines most commonly

(Fig. 9) Ditching by hand in a saltmarsh.
(Barrington, RI. 19 July 1978).



(Fig. 10) Ditch recently cleared by hand. (Barington, RI 9 September 1977).

(Fig. 11) An old mosquito ditch which has become overgrown with saltwater cordgrass (sparting alterniflora). Stagnant conditions which breed mosquitos have been created here and the ditch must be cleared to eliminate them. (Fairhaven, Mass. 18 August 1978).

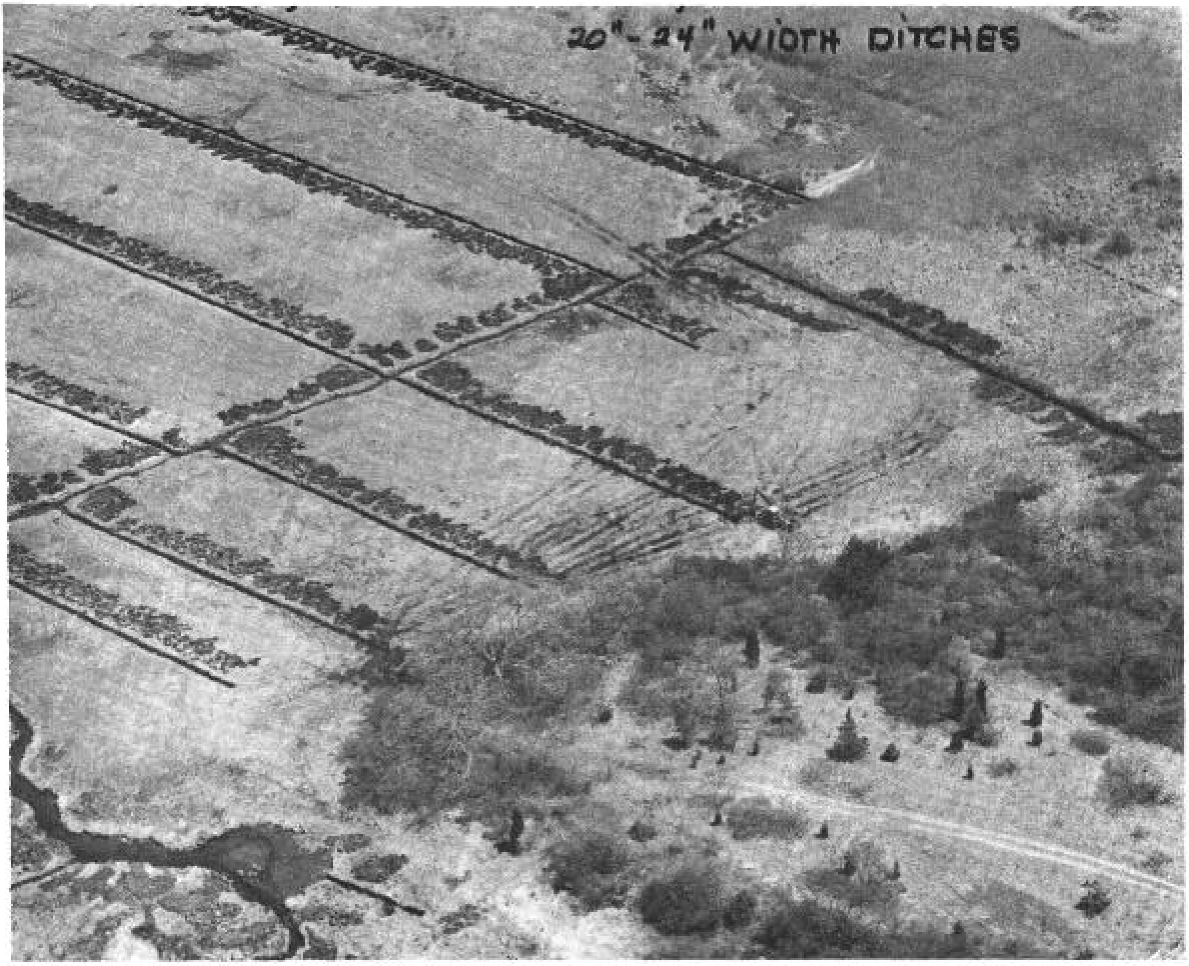
used. Both are track mounted bucket devices with high mobility on the marsh, considerable variability in the configuration of ditch they can work (curved as well as straight), and while being somewhat clumsy, they are capable of spreading spoil fairly evenly and thinly (Figure 12). The clamshell deploys a hinged bucket from cables. The backhoe deploys an unhinged bucket from a mechanical arm (Figure 13). Both devices are usually mounted on wide-axled carriages with the tracks often modified by the addition of wooden planks to increase the track width and disperse the weight of the machinery (Figure 13). This provides the dual advantage of being able to traverse the soft substrate while minimizing scarring of the surface. We noted no evidence indicating long term damage resulting from operation of any of the tracked vehicles. The potential existed, but apparently sufficient care had been exercised to circumvent damage.

Another machine used extensively by the Essex County Project is the scavel plow. This track mounted device employs a vertical digging plow member combined with a horizontal spreading member. As the scavel plow is pushed or pulled, the vertical blade re-cuts the ditch and then the horizontal blade spreads the spoil to both sides, forming mounds, or beads, parallel to the ditch. The size of the mounts is governed by the amount of spoil removed.

C. Impacts of Maintenance Activities

During the course of the summer, we visited a wide variety of sites and observed a number of effects. We were mildly surprised to discover few situations which could be interpreted as potentially adverse impacts resulting from ditch maintenance.

Immediately after clearing, spoil scattered on the marsh was visually unattractive. However, after short recovery periods, it was difficult to tell that work had taken place (Figure 14). Physical evidence of disturbance in the



(Figure 12) Backhoe at work in Great Marsh
on Cape Cod. (Barnstable, Mass. May 1974).

(Figure 13) Backhoe with wooden planks on
tread on Cape Cod Saltmarsh.

(Fig. 14) Ditch and spoil resulting from main_
tenance 1 week earlier on right. Ditch main-
tanined in same manner 1 year earlier on right.
(Newbury, Mass 28 June 1978).

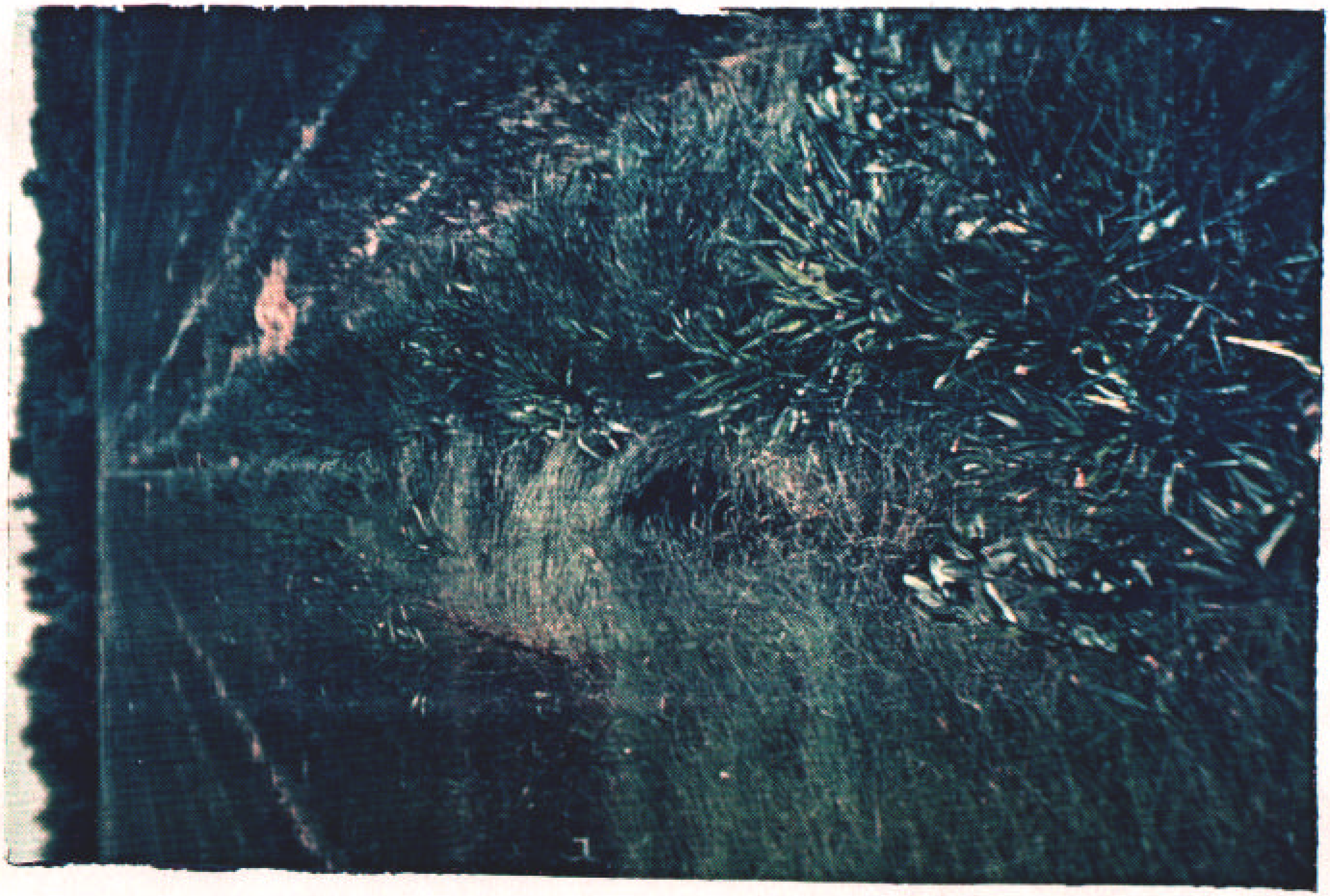
form of small irregularities on the marsh surface could be found where the spoil had been deposited originally. However, the plan community which had recolonized and covered over the spoil appeared identical in composition and density to the undisturbed areas surrounding it. Usually, old spoil could not be seen at all because of the grasses growing on it.

The worst case of spoil deposition was observed in Plymouth County, Massachusetts. Figure 15 shows this area which had been worked by a backhoe approximately 7 days earlier leaving spoil approximately 30 cm. or more deep. Representatives of both the Plymouth Country Mosquito Control Project and the Massachusetts Cooperative Extension Service who were present during the field visit expressed the observation that within one to two years the soil is winnowed out of such a deposit by rain and tides leaving only peat and undecomposed root structures, and that the saltmarsh has re-established itself on the site. It is interesting to note that at a different site in Bristol County, we found a spoil deposit several years earlier by a backhoe which, possibly due to a much sandier composition, was still over 30 cm. high but completely enveloped by saltmarsh grasses, primarily salt meadow grass, S. patens (Figure 16).

In Essex County, we observed a number of ditches which had been cleared by scavel plow with no obvious ill effect even though paired beads of spoil originally had been left paralleling the ditches. Figure 17 shows such a ditch which had been cleared ten years earlier. The spoil beads still exist and range from 4 to 8 cm. high and 8 to 13 cm. wide, yet they are not obvious to the naked eye as they are completely covered by salt meadow grass. The fact that the spoil bead was not visible at this site was most impressive because it could not be seen in spite of the meadow having recently been mowed for hay.

(Fig. 15) Spoil deposited on saltmarsh by recent backhoe work. Layer of spoil to right was approximately 30 cm thick. (Wareham, Mass. 14 August 1978).

(Fig. 16) Spoil pile (left of ditch) deposited several years earlier by a backhoe clearing the ditch. Although pile is over 30 cm high in some places, it has been totally reolonized by marsh plants, primarily grass species such as salt meadow grass, Spartina patens. (Fairhaven, Mass. 18 August 1978).

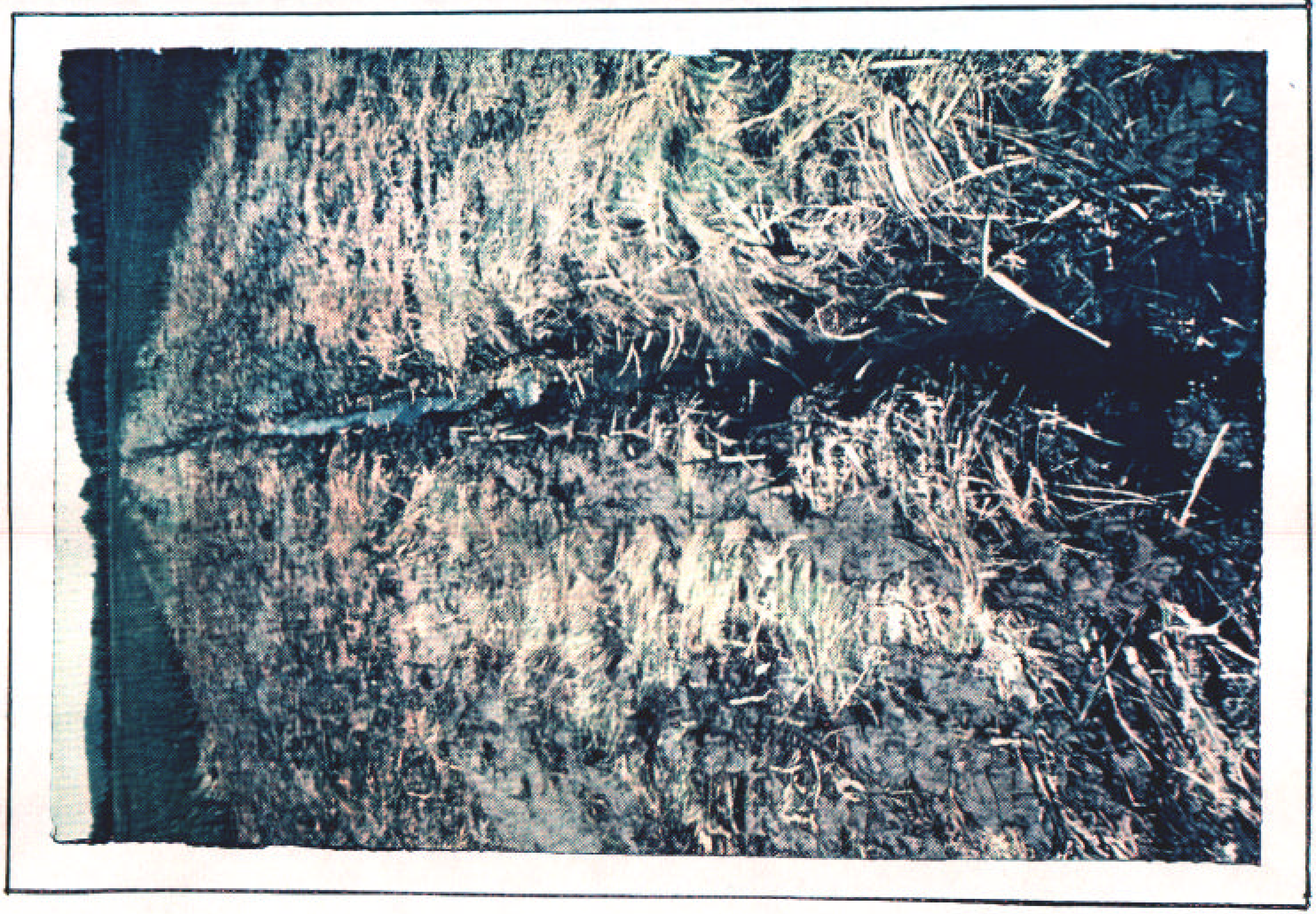


(Fig. 17) Ten years after this ditch was cleared by scavel plow, there is no visible evidence of the bead of spoil. This bead was 4-8 cm in height and ran parallel to the ditch several feet away on either side of it. The wetland including the spoil bead is dominated by salt meadow grass (Spartina patens) which has been moved recently for salt hay. (Newbury, Mass. 28 June 1978).

In recent years, the Essex County Project has been experimenting with a different way to manage the spoil resulting from the scavel plow. They attempted to level the spoil and blade it to the edge of the marsh with a small bulldozer (Figure 18). The immediate results are somewhat unsightly, however, within one year, substantial recovery by the plant community had taken place (Figure 19). The Project expressed that it had not yet decided on the desirability of this technique.

We found that spoil deposits created by clamshells or backhoes could not be placed haphazardly or problems would result. In the great majority of our observations, we found that care had been exercised in the deposition of spoil. Piles were low, and well spread with the result being rapid and thorough re-establishment of the saltmarsh. In some cases, long, unbroken piles of spoil acted as dams, which retarded surface drainage or even pooled water creating mosquito breeding conditions (Figure 20). Another problem, particularly in areas of minimal tidal influence is that the height of the spoil could influence the composition of plant species which recolonized the pile. Figure 21 demonstrates such a situation. On this deposit, found in Plymouth County, occassional specimens of upland plant species such as common ragweed (Ambrosia artemisiifolia) were found growing amidst the primarily saltmarsh community. In this situation, raising the elevation of the pile any higher would undoubtedly cause a shift to an upland community.

Prior to initiating our investigation, we had been led to believe a significant adverse effect of spoil deposition on the saltmarsh was the encouragement of massive invations of woody plant species which limit productivity of the wetland and decrease wildlife habitat value. Therefore, we focused our observations on any signs of woody plant intrusion possibly related to ditching activites. The only woody



(Fig. 18) Ditch cleared 1 week earlier by scavel plow with spoil bladed level and scraped to edge of marsh by bulldozer. (Newbury, Mass. 28 June 1978.

(Fig. 19) Regrowth after one year on saltmarsh along a ditch scavel-plowed with spoil bladed level and scraped to edge of marsh by bulldozer. (Newbury, MA. 28 June 1978.)

Figure 20) In this area of minimal tidal influence, a continuous spoil pile, (background) resulting from a past ditch clearing operation, acts as a dam retarding surface drainage. Breeding conditions have been created by the formation of a shallow, stagnant pool obscured from view by the patch of alkalai grass (Distichlis Spicata) in the central portion of this photograph. (Onset, MA. 14 August 1978).

(Fig. 21) In areas with minimal tidal influence, invasion by tolerant upland species can occur. On this spoil deposit, the plant community is essentially that of a tidal marsh, however, occasional specimens of upland species such as common ragweed (Ambrosia Artemisifolia) can be found. (Onset, Mass. 14 August 1978.

plant we found in our field visits was marsh elder (Iva frutescens). Generally, we found very little or no marsh elder. However, in the upper portions of estuaries, we did find a tendency for this plant to be associated with ditches. In these areas, freshwater influx would be at it greatest. Further, when found, the marsh elder favored the edges of the ditches and the area around spoil piles more than the spoil itself. This suggests the mechanism for encouraging this species is not the deposition of spoil as we were led to believe. Perhaps simply the disturbance of working the ditch, or disturbance in combination with freshwater influx is the operating mechanism.

In most areas, however, there was no invasion by marsh elder, or so little over great time spans (e.g. 10 years), that we felt no adverse impact was occurring. In the few areas that the invasion by marsh elder was more apparent, the degree of invasion was still not sufficiently severe to suggest obvious adverse impact. The worst case we encountered was in the upper reaches of a Plymouth County tidal marsh (Figure 22). Here heavy growth of marsh elder followed ditches cleared 7 years earlier. Likewise, heavy growth occurred around some of the spoil piles with light growth on some of the piles. As the ditches approached the Agawam River, where tidal and saltwater influence would be greatest, occurrance appeared to decline proportionately. Little or no growth of marsh elder was observed more than 2 to 3 meters from the ditches. The plant community in the remainder of the marsh was typical of a New England salt meadow and plant growth was vigorous.

On the Barnstable Marsh on Cape Cod, we observed another situation involving freshwater influx on a saltmarsh. Here a ditch paralleling the upland edge was apparently carrying off water heavily influenced by upland influx of fresh water (Figure 23).

(Fig. 22) Heavy growth of the woody plant, marsh elder (Iva frutescens) around ditch cleared 7 years earlier in upper estuary. Marsh elder was most abundant at edge of ditch itself and on the original marsh surface not covered by spoil; it appeared to be less abundant or absent from the clumps of spoil themselves. (Wareham, MA. 14 August 1978).

(Fig. 23) Ditch parallels upland edge of marsh. Note heavy growth of broadleaf saltmarsh plants, primarily Seaside Goldenrod (Solidago semprevirens), to upland side (right) and conspicucus absence of these plants to the seaward side (left) of ditch. Ditch may be carrying off surficial flow of fresh water creating differing environment for the plant community of either side of the ditch. (Barnstable, Ma., 25 July 1978).

On the marsh between the ditch and the upland edge, there was heavy growth of broadleaf saltmarsh plants such as seaside goldenrod (Solidago sempervirens) and marsh elder. On the seaward side of the ditch, such growth was conspicuously absent. While these plants normally inhabit saltmarshes, they may gain some competitive advantage over saltmarsh grasses in areas of lower salinity. In this case, the ditch abruptly cuts the path freshwater seepage would most likely travel. The freshwater then tends to flow away within the ditch. We believe this is a probable explanation for the phenomenon observed.

Saltmarsh sod displayed some resiliency to environmental insult. Spoil, including sod, seemed to be recolonized extremely rapidly by saltmarsh plants. Several times we found clumps of salt meadow grass which had taken root and continued to grow where it was dropped as long as it was placed with the roots down (Figure 24).

In Essex County, we observed another interesting phenomenon. Ten years earlier, a shallow salt pan (pool) had dewatered as a result of a clearing operation on a ditch located 10 meters away. One year later, the formerly "barren" area was thickly covered with glasswort (Salicornia sp.). The second year, and for all the years following the area succeeded to the short form of saltwater cordgrass (Spartina alterniflora (Figure 25).

(Fig 24) New roots protruding from a clump of salt meadow grass (Spaeting pateus) which had been recently deposited (roots down) on a salt marsh after hand clearing of a clogged ditch. (Fairhaven, Mass., 18 August 1978).

(Fig. 25) After a nearby ditch had been cleared 10 years earlier, this "salt pan" area (foreground) dewatered and suceeded to Spartina Alterniflora short form. (Newbury, Mass. 28 June 1978).

IV. Summary

In summation, the following points are in order regarding mosquito ditching work and spoil deposition on Massachusetts tidal wetlands.

- Work is limited primarily to clearing existing ditches.
- Clogged ditches restrict flow and often pose serious problems as mosquito breeding areas themselves. As a result, some level of maintenance activity is essential to the coastal Mosquito Control Projects.
- Few or no new ditches are being excavated.
- Crew size and funding have decreased steadily, costs have increased, yet the amount of area for which the Projects have responsibility has remained the same.
- Massive invasion of woody and/or non-marsh plant species was absent; minor influx of woody species was noted occassionally, but it was not obviously correlated to spoil disposal. Further, it was not apparently creating adverse conditions for wildlife.
- In general, the Projects believed ditch maintenance was much more desirable as a control technique than was the use of insecticides.
- In General, the Projects displayed a high level of knowledge and appreciation of the values of saltmarsh ecosystems, and their efforts were directed at minimizing or avoiding possible adverse impacts.
- The Projects were very cooperative with this investigation.

V. Recommendations

Based on the information we collected, and on our direct observations to date, we believe the following recommendations are in order regarding action on this matter by the New England Division.

1. Develop a General Permit with consistent statewide standards for maintenance of mosquito control ditches within Massachusetts. Mosquito Control Projects can apply individually and would be evaluated on their own individual performance and adherence. The permits could be renewable annually.

2. Develop a program of periodic monitoring of these permits.

3. Encourage testing, where feasible, of open marsh water management techniques, the aim of which is to pond water deep enough to hold fish populations. Such techniques may not only control mosquitos, but also have the additional benefit of providing habitat for other desirable marsh species.

4. Require statistical documentation of mosquito problems in areas proposed for new ditches; require a regular permit for such work.

5. Monitor the results of the blading technique being tested in Essex County to determine its long term effects and, subsequently, its desirability.

6. Monitor the deposits with the greatest depth and least spreading of spoil (e.g., the Plymouth County site in Figure 15) to determine the long term effect and, subsequently, the desirability of this technique.

7. Continue to survey the remainder of the New England coastal wetland mosquito control programs in a similar manner.

8. Based on contacts made during the coastal survey, develop and conduct a similar survey of mosquito control work resulting in spoil deposition in New England's inland wetlands.

APPENDIX I

7 July 1978

Gentlemen:

This letter is being sent to all mosquito control project areas in Massachusetts.

We understand that you are conducting a mosquito control program that may be utilizing various open marsh water management techniques. Because of recent changes in Federal law, some activities previously unregulated now require Corps of Engineers permits. If your program includes the following, a Corps of Engineers permit will be required.

a. Cutting or clearing new mosquito ditches in tidal areas below mean high water.

b. Placement of material excavated from existing or new ditches on saltmarshes or freshwater wetlands.

We plan to develop a general permit to cover mosquito control program throughout the State. The intent of this procedure is to process one permit application for the entire mosquito control project rather than process many individual permits for small portions of each project. Minor projects that are noncontroversial and have minimal adverse effects on the environment are considered suitable for general permits. The end result will be a permit that will accommodate your ongoing programs with minor, if any, modifications while at the same time maintaining reasonable environmental controls.

Since your projects are currently serving a public need, we will not stop your work while a permit is developed.

In the near future, hopefully before the end of this growing season, we will visit each district. We would like to see sites of previous ditching activity and areas of current activity. In coastal areas, these visits will be scheduled to coincide with low tide. At a later date, you may be required to provide specific information relating to your program including numbers and sizes of ditches, and maps of areas requiring ditch maintenance.

If you have any questions or comments please feel free to call Mr. Robert DeSista at 617-894-2400, extension 372.

Sincerely yours,

MORGAN R. REES
Chief, Regulatory Branch
Operations Division

APPENDIX II

24 October 1978

Questionnaire Seeking Status of Mosquito Control Work in Massachusetts Wetlands

1. How long has your Control Project been in existence?

2. What is your organizational and managerial set-up? i.e., Board of Commissioners, Superintendent, etc.

3. How is your project funded?

4. How is your project staffed?

5. What is your best estimate of the approximate acres of (a)tidal and (b)non-tidal wetlands in your area? Approximately, how many acres of each type contain mosquito ditches?

6. What is your best estimate of the number of miles of (a)tidal and (b)non-tidal ditches that you have?

7. When were the majority of your ditches originally cut?

8. Briefly describe your ditch maintenance techniques to include:

   a. Mechanical methods - i.e., backhoe, or other wide track vehicle
   b. Manual methods
   c. To what extent is each method used

9. Where and how is the spoil deposited for each method?

10. How often does a ditch require clearing by (a)mechanical and (b)manual maintenance techniques?

11. What are the typical dimensions of your ditches in a cross-sectional view?

12. Are similar maintenance techniques employed for both tidal and non-tidal wetlands? How might they vary?

13. On a typical tidal wetland, how does the elevation of the bottom of the ditch at both waterward and shoreward ends relate to the mean high water level, or how do you ensure tidal flushing at the landward ends of the ditches?

14. During what periods of the year is the ditch maintenance conducted?

15. How are your maintenance priorities and schedules set?

16. Are larval surveys conducted? If so, briefly describe.

17. Do you anticipate the need to cut new ditches. Why, how often, and how long would they be?

18. How often are you required to place culverts, drainage pipes or similar structures below the mean high water level to make connections through dunes or beaches to allow tidal flow to ditches?

19. On an annual basis, would you be able to report on the extent (length), general location, and type (manual and/or mechanical) of ditch maintenance performed?

20. Do you use insecticides on your marhes? Which types do you use? How and when are they applied (time of year), and what quantities are used?

21. Are insecticides applied in conjunction with the ditch maintenance or is it a separate feature of your program?

22. Can you think of any other mosquito management techniques that could effectively be employed on your marshes?

23. If possible, please provide a map showing the boundaries of your project jurisdiction. Also, indicate the wetlands with major ditching activity and your problem area wetlands.

24. Please provide any additional comments or suggestions.